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Photometric Parameters of RR Lyr Variable Stars in the Galactic Bulge

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Abstract

We present a complete set of OGLE photometric measurements for 214 RR Lyrae variables in the Galactic bulge, based on four observing seasons: 1992–95. These are mostly I-band measurements, with some V-band observations obtained mainly in 1995. Based on this material we construct the Fourier decomposition of the I-band light curves and investigate different types of RR Lyr variability. We also determine the value of the extinction-insensitive parameter V_{V-I} for RR Lyr stars in fields with different galactic longitude l and compare with values of V_{V-I} calculated for red clump stars by Stanek *et al.* (1994).

The observed and free from interstellar extinction mean brightness and $V-I$ color of RR Lyr stars are also presented.
Key words: *Stars: oscillations – Catalogs*

1 Introduction

The Optical Gravitational Lensing Experiment (OGLE) is a long term observing project which main goal is an extensive photometric search for gravitational microlensing events (Paczyński 1986, Udalski *et al.* 1992). For this purpose the CCD photometry of a few millions stars in dense regions near the center of Galaxy was performed. Up to now, after four seasons of observations (years 1992–1995) nineteen microlensing events have been detected (Udalski *et al.* 1993b, 1994a, 1994b, Paczyński and Udalski 1996). All the data were obtained with the 1-m Swope telescope at the Las Campanas Observatory in Chile, operated by Carnegie Institution of Washington with a 2048×2048 Ford/Loral CCD detector with scale 0.44"/pixel.

Such a large amount of precise photometric data give us an opportunity to study different types of stellar variability (Udalski *et al.* 1994c, 1995a, 1995b, 1996, 1997), to obtain good quality color magnitude diagrams (Udalski *et al.* 1993a), to construct a catalog of all stars observed in Baade's Window (Szymański *et al.* 1996) or to study the Galactic structure (Stanek *et al.* 1994, 1997). Data collected during the search for periodic variable stars in the central part of our Galaxy were published as The Catalog of Periodic Variable Stars in The Galactic Bulge (Udalski *et al.* 1994c, 1995a, 1995b, 1996, 1997). The Catalog contains I-band light curves, $V-I$ colors, periods, equatorial coordinates of stars with $\langle I \rangle$ and period in range 14–18 mag and 0.1–100 days respectively.

Discovered variable stars were grouped into three categories: pulsating stars (mostly RR Lyr and δ Sct stars), eclipsing stars (mostly W UMa, β Lyr and Algol type) and miscellaneous variables (mostly late type, chromospherically active stars, ellipsoidal variables and a few Miras).

Investigation of eclipsing and miscellaneous stars from OGLE data have been already performed (Ruciński 1997a, 1997b, Olech 1996). The main aim of this paper is to provide more information about photometric parameters of RR Lyr variable stars from the Galactic bulge.

2 RR Lyr Stars in OGLE Catalog of Periodic Variable Stars

2.1 Statistics

Recently OGLE Collaboration published five parts of their Catalog of Periodic Variable Stars in the Galactic Bulge (Udalski *et al.* 1994c, 1995a, 1995b, 1996, 1997). Precise light curves, colors and finding charts for almost 3000 variable stars were presented. Among them 214 RR Lyr stars were detected. Table 1 summarizes results presented in the Catalog and gives galactic coordinates of the OGLE $15' \times 15'$ fields and number of RR Lyr stars detected in each of them. One can notice that number of RR Lyr stars in BWC field is significantly larger than in other fields. This is caused by the fact that all BW fields overlap with neighboring fields by 1 arcmin and stars discovered in common regions of BWC and other fields were counted as BWC variables.

Table 1

RR Lyr Stars in OGLE Fields.

Field	l	b	RR Lyr
BWC	1.0°	−3.9°	27
BW1	1.1°	−3.6°	16
BW2	0.7°	−3.8°	8
BW3	0.9°	−4.2°	15
BW4	1.3°	−4.0°	14
BW5	0.9°	−3.7°	13
BW6	0.8°	−4.0°	13
BW7	1.1°	−4.1°	12
BW8	1.2°	−3.8°	11
BW9	0.9°	−3.3°	16
BW10	0.7°	−3.4°	21
BW11	0.5°	−3.5°	12
MM5-A	−4.8°	−3.4°	14
MM5-B	−4.9°	−3.5°	10
MM7-A	5.4°	−3.3°	8
MM7-B	5.5°	−3.5°	10

Data presented in this work were collected during four observational seasons (1992–95). Average numbers of I-band and V-band measurements amounted to about 100–200 (depending on the field) and over 20 respectively. Majority of V-band data were obtained during the 1995 season. Complete set of above mentioned data is available via INTERNET in electronic form (ftp host: sirius.astrouw.edu.pl, directory: */ogle/var_catalog*).

2.2 Fourier Coefficients for RR Lyr stars in Baade's Window

To be able to classify various light curves of RR Lyr variables in some algorithmic way we constructed a Fourier fit in the form:

$$I = a_0 + \sum_{k=1}^{3} \{a_k \cdot \sin(\frac{2k\pi(t-t_0)}{P}) + b_k \cdot \cos(\frac{2k\pi(t-t_0)}{P})\} \quad (1)$$

for each I-band light curve of RR Lyr star in OGLE Catalog. Coefficients a_k and b_k were calculated by least squares method and $t_0 = 2448000.0$ HJD. The results are presented in Tables 2–6. Such a decomposition of light curve can be potentially used to distinguish between different kinds of RR Lyr and also to determine physical properties of these stars e.g. absolute magnitude and metallicity. Fig. 1 gives I-band light curves of six RR Lyr stars from BW1 with solid line showing the fit given by the Eq. (1).

Table 2
Fourier coefficients for BWC and BW1 RR Lyr stars.

Star	Period	a_0	a_1	a_2	a_3	b_1	b_2	b_3
BWC V6	0.42765	15.11787	0.01603	0.04570	0.05702	–0.15597	–0.04459	0.02319
BWC V14	0.44022	15.69728	0.22144	–0.10376	0.06836	0.17845	–0.07848	0.08727
BWC V15	0.45871	15.71623	0.01104	0.01575	–0.02014	0.20202	–0.04353	0.01021
BWC V17	0.29872	15.33980	0.01980	0.01788	–0.01424	0.12980	–0.00286	–0.00528
BWC V22	0.48968	15.75357	–0.23042	0.05772	0.14641	0.15559	0.18418	0.02135
BWC V23	0.45426	15.82007	0.30212	0.03852	–0.12980	–0.13698	0.27124	–0.05865
BWC V25	0.47418	15.71959	–0.04423	–0.01694	0.02301	–0.21444	–0.06483	–0.01531
BWC V26	0.47863	15.83531	0.12667	0.08377	–0.02398	–0.20163	0.04397	0.07948
BWC V28	0.59478	15.63364	0.03668	0.06184	–0.06175	0.15190	–0.03995	–0.02804
BWC V30	0.57147	15.66380	0.09582	0.03981	–0.03078	–0.11955	0.07138	0.00549
BWC V33	0.55032	15.83123	0.15391	–0.06875	0.03131	0.04492	–0.01033	0.02300
BWC V35	0.33048	15.61170	0.11396	–0.00048	0.01274	–0.04832	0.02117	0.00839
BWC V37	0.38016	15.71013	–0.08233	0.00132	0.01138	–0.10230	–0.00616	0.00039
BWC V41	0.46214	15.99924	0.20650	–0.09692	0.03934	0.09486	0.01275	–0.00384
BWC V47	0.25692	15.76428	–0.00628	0.02310	0.00563	0.06542	0.00325	–0.00214
BWC V48	0.33546	15.80626	0.11752	0.00956	0.01069	0.07251	–0.02721	–0.03532
BWC V51	0.64949	15.80904	0.02438	0.00649	–0.00662	0.06748	–0.01255	–0.00099
BWC V54	0.28870	15.88149	–0.13840	–0.01482	–0.00439	–0.04686	–0.00739	–0.01112
BWC V56	0.68046	15.79886	0.04202	0.02515	0.00362	0.07483	–0.01293	–0.01304
BWC V59	0.26995	15.92907	0.10475	0.00316	–0.02250	0.11769	–0.02159	0.01841
BWC V60	0.32069	15.90652	0.03105	0.00408	0.01013	–0.11555	0.00931	0.00067
BWC V61	0.61595	15.91442	–0.08228	–0.01083	0.00406	–0.04895	–0.03462	–0.01377
BWC V62	0.28682	15.94575	0.03045	0.02206	–0.01766	–0.13968	0.00755	0.00835
BWC V65	0.55720	16.25534	0.05863	0.10905	–0.07666	–0.19081	0.05050	0.04403
BWC V81	0.38590	16.32912	–0.02116	0.00381	0.00326	0.04954	0.01177	0.00647
BWC V106	0.46496	16.98680	0.06253	–0.01122	0.00392	0.16846	–0.03590	0.01850
BW1 V7	0.46006	15.01576	–0.02240	0.00906	0.02357	–0.05348	–0.03702	–0.01078
BW1 V10	0.55564	15.39061	0.12845	0.04790	–0.08271	0.17708	–0.14840	0.03186
BW1 V11	0.38434	15.22302	0.04042	–0.00299	–0.01707	–0.12515	0.00368	–0.00575
BW1 V14	0.49322	15.55832	0.03253	0.08892	0.00747	–0.21482	–0.03624	0.07540
BW1 V18	0.52956	15.73140	–0.13519	0.10091	0.06874	0.20490	0.07792	–0.04383
BW1 V19	0.44444	15.81823	–0.25610	–0.12643	–0.06836	–0.09761	–0.05660	–0.06691
BW1 V21	0.45411	15.81379	–0.01311	0.08927	–0.08576	0.24706	–0.05365	–0.04995
BW1 V25	0.60023	15.68415	–0.06749	0.08334	0.06161	0.16993	0.06321	–0.02440
BW1 V31	0.42434	16.04257	–0.10248	0.05804	0.02722	0.18639	0.03659	–0.02078
BW1 V32	0.30529	15.72653	0.03150	–0.01411	–0.01006	–0.13423	–0.00190	–0.00208
BW1 V34	0.63271	15.88880	–0.08460	0.00672	0.03775	–0.13748	–0.05135	–0.02145
BW1 V36	0.44856	16.19532	–0.28328	–0.12088	–0.06208	–0.02125	0.05809	0.06630
BW1 V40	0.61175	15.84933	0.01242	0.04482	0.00367	0.12063	–0.01256	–0.02590
BW1 V43	0.42178	16.19170	–0.15412	–0.04956	–0.01251	–0.15473	–0.11802	–0.03584
BW1 V50	0.31992	16.06068	0.09004	0.01036	–0.00873	0.07912	–0.02550	0.01269
BW1 V53	0.31963	16.10365	–0.10526	–0.01148	–0.00306	0.07111	–0.00109	0.01793

Table 3
Fourier coefficients for BW2, BW3 and BW4 RR Lyr stars.

Star	Period	a_0	a_1	a_2	a_3	b_1	b_2	b_3
BW2 V8	0.39402	15.30095	0.03561	0.01842	–0.04255	–0.15957	0.01801	0.00109
BW2 V10	0.50784	15.370	–0.00073	0.01476	0.01702	–0.11369	–0.00037	–0.00203
BW2 V14	0.77102	15.57770	–0.09443	0.03013	0.00661	0.15949	0.07471	0.00726
BW2 V17	0.47838	15.98977	–0.24328	–0.00783	0.05207	0.08448	0.17404	0.02971
BW2 V18	0.62432	15.63196	0.04788	–0.00905	0.00174	0.01126	–0.00004	–0.00367
BW2 V23	0.49276	16.23642	–0.00164	0.05716	0.06564	–0.23865	–0.05574	0.01775
BW2 V24	0.59743	15.85332	0.07513	0.01934	–0.02928	0.09557	–0.04980	0.00552
BW2 V42	0.28954	16.46074	–0.06715	0.03874	0.02568	–0.14691	–0.02812	0.00881
BW3 V11	0.65494	15.35452	0.10792	0.06812	–0.04491	–0.17746	0.09222	0.02124
BW3 V13	0.45751	15.71935	–0.10555	0.11798	0.04780	0.21182	0.04801	–0.05458
BW3 V16	0.60354	15.66343	–0.18356	–0.09563	–0.05269	–0.04425	–0.03095	–0.02094
BW3 V17	0.40333	16.03220	–0.26998	–0.12746	–0.08647	0.00347	0.04934	0.08525
BW3 V21	0.77304	15.68117	0.00470	0.04666	0.00763	0.10610	0.00311	–0.01799
BW3 V26	0.33435	15.831	–0.06836	0.02112	–0.00734	–0.11289	–0.01370	0.01559
BW3 V41	0.26263	16.04087	0.01567	0.00925	–0.00481	0.13983	–0.00422	–0.00801
BW3 V43	0.64089	15.97926	–0.03492	0.01260	–0.00494	–0.07085	–0.01535	0.00590
BW3 V46	0.48653	16.22392	–0.07655	0.10706	0.09037	–0.19787	–0.09806	0.02662
BW3 V48	0.25073	16.09169	–0.03280	0.02393	0.00320	–0.08555	–0.01446	0.00233
BW3 V61	0.54160	16.59679	0.12457	0.04840	–0.06556	–0.16219	0.09705	–0.00834
BW3 V66	0.29103	16.42890	–0.04403	0.00950	–0.01221	0.12427	0.01406	0.00046
BW3 V81	0.50818	16.72673	0.11199	–0.01102	–0.02497	0.08767	–0.06718	0.03610
BW3 V99	0.56046	17.10945	–0.00514	0.14239	0.00074	0.22057	–0.01177	–0.08083
BW4 V4	0.31997	15.03589	–0.04851	–0.00473	0.00089	0.00327	–0.00121	0.00426
BW4 V5	0.47468	15.43992	0.20599	–0.08595	0.04447	0.03323	0.05749	–0.07734
BW4 V8	0.51586	15.47024	0.14576	–0.04536	–0.01928	0.15356	–0.10313	0.07256
BW4 V9	0.46317	15.60021	0.10146	0.12321	–0.00290	–0.23458	0.02154	0.09952
BW4 V11	0.60169	15.33607	–0.13875	–0.06246	–0.03660	–0.01995	0.00198	0.01320
BW4 V12	0.63958	15.44754	0.18674	–0.09813	0.06261	–0.02285	0.00211	0.00683
BW4 V22	0.56093	15.80406	–0.01453	0.10079	0.06128	–0.17942	–0.04395	0.05075
BW4 V25	0.32191	15.73668	–0.11834	0.00052	0.00792	–0.05393	–0.01552	–0.00154
BW4 V27	0.34744	15.70794	0.03251	–0.00295	0.00064	–0.01658	0.00323	–0.00238
BW4 V31	0.32701	15.84757	0.02624	0.00802	–0.01117	–0.13263	0.00574	–0.00422
BW4 V43	0.55992	16.07776	0.08331	0.04332	–0.03439	–0.12114	0.05432	0.01278

Table 4
Fourier coefficients for BW5, BW6, BW7 and BW8 RR Lyr stars.

Star	Period	a_0	a_1	a_2	a_3	b_1	b_2	b_3
BW5 V13	0.49492	15.74369	–0.22417	–0.06462	–0.03345	–0.02542	0.01096	0.03057
BW5 V17	0.27929	15.47744	0.07933	0.00733	–0.01147	–0.11756	0.02435	0.00171
BW5 V24	0.55213	15.73153	–0.14598	–0.09262	–0.06636	0.09943	0.02786	–0.02964
BW5 V28	0.46723	16.03722	–0.08302	0.14263	–0.03555	0.24815	0.00437	–0.12243
BW5 V29	0.47361	16.03377	0.23912	–0.12540	0.10197	0.07024	0.00998	–0.03506
BW5 V34	0.49027	16.14363	0.23680	–0.08742	0.02517	–0.02353	0.08573	–0.08483
BW5 V36	0.59451	15.88070	0.08675	0.00215	–0.02257	0.10078	–0.04973	0.00802
BW5 V39	0.50786	16.31342	–0.21866	–0.02027	0.03603	0.08273	0.12764	0.02889
BW5 V40	0.32586	16.00048	0.12528	–0.00753	0.01011	–0.03214	0.01322	–0.00217
BW5 V43	0.45997	15.98198	–0.02487	0.00563	–0.00023	0.02545	0.01151	–0.00123
BW5 V50	0.49635	16.40812	0.00279	0.03571	–0.06864	0.22033	–0.05874	–0.03346
BW5 V135	0.58825	17.70118	0.07639	–0.02503	0.00666	–0.02952	0.04732	–0.02411
BW5 V174	0.56146	18.91344	–0.23086	–0.17669	–0.04552	–0.09183	0.07547	0.05427
BW6 V7	0.52501	15.43896	0.05666	0.11906	0.02399	–0.25096	–0.00951	0.06544
BW6 V12	0.55603	15.62931	–0.26848	0.01874	0.11584	0.15383	0.21035	0.10218
BW6 V15	0.55745	15.52499	–0.10491	–0.02593	0.01222	–0.08512	–0.07019	–0.03755
BW6 V17	0.65163	15.58864	–0.03241	0.04355	0.01908	0.14238	0.02348	–0.02593
BW6 V18	0.54140	15.92709	–0.11033	0.07300	0.07244	0.19037	0.05496	–0.01885
BW6 V20	0.39370	15.95989	0.18270	–0.08668	0.02316	0.17062	–0.08077	0.07214
BW6 V27	0.58400	15.75801	–0.14995	–0.06970	–0.03793	–0.02703	–0.00286	0.00889
BW6 V29	0.56290	15.89626	–0.08588	0.03675	0.03889	–0.14096	–0.07449	0.00162
BW6 V32	0.31333	15.82354	0.09456	–0.00719	–0.00737	0.09004	–0.00417	–0.00163
BW6 V35	0.43124	16.24859	0.22420	–0.11523	0.06165	0.17803	–0.07829	0.08456
BW6 V36	0.32026	15.86359	–0.05740	0.00588	0.00134	–0.10712	–0.00609	0.01073
BW6 V44	0.24855	16.01323	0.03091	0.04952	–0.00224	–0.11472	0.01885	0.00991
BW6 V46	0.30942	16.07095	–0.01235	0.00807	–0.01622	–0.10305	–0.00009	0.00557
BW7 V8	0.50711	15.24365	–0.17698	–0.01089	0.04847	–0.16168	–0.13848	–0.07950
BW7 V15	0.49708	15.61519	–0.24593	–0.04756	0.05030	0.00903	0.09362	0.15396
BW7 V18	0.66695	15.68157	–0.13058	–0.08522	0.04771	–0.12733	–0.06307	–0.01598
BW7 V20	0.77051	15.57981	–0.13360	–0.01937	0.03557	–0.11187	–0.10660	–0.07047
BW7 V23	0.60579	15.47907	0.00493	0.01661	0.01408	0.06425	0.00496	0.01379
BW7 V24	0.26902	15.54379	–0.08860	–0.02298	0.00475	–0.00269	–0.00793	–0.00634
BW7 V25	0.52116	15.76348	–0.15565	0.02516	0.05714	0.11551	0.09462	0.04389
BW7 V30	0.36202	15.77208	–0.09676	–0.00761	–0.00147	0.01737	–0.00622	–0.00510
BW7 V31	0.29191	15.79245	0.04443	0.01537	–0.00972	0.09211	–0.01626	–0.01423
BW7 V33	0.51122	16.15760	0.14645	0.067	–0.07103	–0.13305	0.10726	0.03626
BW7 V48	0.63862	16.36857	–0.15123	–0.04067	–0.04215	0.02684	0.08024	0.05194
BW7 V51	0.27215	16.23314	0.13253	0.00308	–0.01010	0.03316	–0.03339	0.00837
BW8 V7	0.55454	15.19504	–0.18544	–0.09369	–0.04351	–0.05748	–0.03368	–0.06820
BW8 V8	0.78117	15.13834	–0.06450	0.04008	–0.00211	–0.15251	–0.03431	0.03097
BW8 V15	0.57724	15.43612	0.10483	–0.03919	–0.00381	0.12081	–0.06165	0.02971
BW8 V16	0.42413	15.63486	0.24479	–0.14020	0.06679	0.04301	0.05651	–0.04042
BW8 V18	0.70001	15.36377	0.02815	0.03650	–0.03597	0.13366	–0.01826	–0.01448
BW8 V20	0.67699	15.37804	0.07722	0.01292	–0.01311	–0.10345	0.05424	–0.01365
BW8 V26	0.61699	15.48143	0.01759	0.01907	–0.00690	–0.06553	–0.00096	–0.00086
BW8 V28	0.53525	15.88063	0.22784	–0.08645	0.04224	–0.05574	0.08388	–0.06101
BW8 V34	0.32037	15.69600	0.04183	–0.01244	–0.00256	–0.11836	–0.00027	–0.00187
BW8 V35	0.64770	15.63083	–0.03268	0.00110	0.00622	–0.04185	–0.01501	0.00548
BW8 V36	0.28612	15.78090	0.00710	–0.00267	–0.01242	–0.14495	0.00500	0.00697

Table 5
Fourier coefficients for BW9, BW10 and BW11 RR Lyr stars.

Star	Period	a_0	a_1	a_2	a_3	b_1	b_2	b_3
BW9 V14	0.60755	15.67594	0.03750	0.18716	0.04929	–0.265	–0.00639	0.12424
BW9 V15	0.48592	15.81885	0.05686	0.08996	–0.11034	0.25305	–0.11916	–0.00948
BW9 V22	0.63233	15.70985	–0.01539	0.06115	0.02738	0.155	0.00343	–0.03450
BW9 V24	0.47635	15.89431	–0.05614	0.05746	0.01684	–0.24337	–0.109	–0.00866
BW9 V34	0.44930	16.09160	–0.00948	0.11077	–0.05787	0.26449	–0.05935	–0.01167
BW9 V35	0.59252	15.94749	–0.07101	0.06420	0.02670	–0.14381	–0.05221	0.01081
BW9 V37	0.54705	16.03117	0.14788	–0.06232	–0.02678	0.09852	–0.10603	0.07518
BW9 V38	0.30574	15.88839	–0.01008	0.01025	–0.02362	–0.11762	0.00685	0.00304
BW9 V43	0.33260	15.98245	–0.13432	–0.01537	–0.00434	0.02014	0.02522	0.03012
BW9 V51	0.67741	16.22408	–0.04713	0.05804	–0.02025	0.16145	0.01879	–0.04175
BW9 V52	0.34218	16.07193	–0.10525	–0.01760	0.04511	0.10789	–0.01454	0.04604
BW9 V54	0.54766	16.25378	0.08813	0.13094	–0.10769	–0.21414	0.07819	0.03125
BW9 V55	0.42564	16.37788	0.08224	0.07466	–0.25121	0.35862	–0.12076	0.07347
BW9 V59	0.54499	16.42001	0.07427	0.14450	0.00596	0.24228	–0.08669	–0.08117
BW9 V114	0.20767	16.90682	–0.10789	–0.01132	–0.00158	–0.02055	–0.01153	–0.01480
BW9 V215	0.30284	17.82195	–0.06458	0.00055	–0.00796	–0.04049	–0.00191	0.00621
BW10 V8	0.71337	15.10997	–0.13883	0.04548	0.06250	0.19182	0.10997	–0.00180
BW10 V14	0.48410	15.43848	0.22086	–0.12785	0.05796	0.08062	–0.05926	0.06985
BW10 V20	0.52711	15.74564	–0.15945	0.08759	0.03315	0.19493	0.08116	–0.06317
BW10 V21	0.52204	15.49528	–0.12522	–0.04779	–0.01772	–0.00815	–0.02538	–0.00654
BW10 V27	0.25828	15.60068	0.03626	0.04846	–0.02555	0.13236	–0.02561	–0.00476
BW10 V36	0.27700	15.66528	–0.08551	–0.00145	–0.01159	0.02356	0.00473	–0.02121
BW10 V39	0.51363	16.01677	0.12177	0.05907	–0.04160	–0.13580	0.04981	0.01644
BW10 V40	0.68277	15.75784	0.04401	0.06504	–0.01188	0.12006	–0.02501	–0.01914
BW10 V41	0.62690	15.97526	0.19554	0.00727	0.00064	–0.09987	0.11692	0.00322
BW10 V44	0.52727	15.97825	–0.16906	–0.05581	–0.03842	–0.06636	–0.06060	–0.01437
BW10 V45	0.25283	15.82750	0.08871	–0.02732	0.01504	0.07542	–0.00145	–0.00738
BW10 V46	0.32542	15.91897	–0.14226	–0.00847	0.01862	–0.04850	–0.04286	–0.03933
BW10 V48	0.32333	15.90164	–0.13477	–0.00085	0.02157	–0.03972	–0.06821	–0.05217
BW10 V51	0.27651	15.96364	–0.08011	–0.00689	0.00413	–0.07544	–0.00740	–0.00159
BW10 V56	0.61826	15.97134	–0.07741	–0.02066	–0.00403	0.00611	–0.00276	0.00799
BW10 V59	0.31930	16.05074	–0.06682	0.00278	0.01417	0.10301	0.01773	0.01681
BW10 V60	0.30371	16.15556	0.14915	–0.01673	0.01003	0.01147	0.01265	0.00661
BW10 V65	0.28099	16.15793	–0.03777	0.04037	0.04111	0.16940	0.01602	–0.01399
BW10 V66	0.58123	16.35251	–0.10078	0.02382	0.03801	0.12306	0.05516	–0.00723
BW10 V70	0.28301	16.21685	0.14472	–0.02278	0.00709	0.02446	0.00599	0.01668
BW10 V95	0.63810	16.66445	0.06559	0.02317	–0.03673	0.11754	–0.05475	–0.00215
BW11 V3	0.59598	14.57884	–0.00511	0.03404	–0.03224	–0.21365	–0.05201	0.02121
BW11 V10	0.45066	15.65054	0.08474	0.04920	0.02891	–0.23224	–0.02664	0.06349
BW11 V17	0.49491	15.85333	0.12509	0.12631	0.01748	–0.25723	0.04715	0.11588
BW11 V23	0.27402	15.62907	–0.12778	–0.01440	–0.02054	0.05640	0.01454	–0.03761
BW11 V25	0.51660	15.96370	0.32168	–0.16352	0.03204	0.02419	0.16834	–0.11914
BW11 V29	0.46610	16.05572	0.19887	0.00055	–0.05268	–0.12174	0.12812	–0.02661
BW11 V34	0.34167	15.83525	–0.04116	0.02383	0.01017	0.12315	0.01428	–0.00247
BW11 V36	0.51394	16.11506	0.13526	–0.05910	0.01098	0.14378	–0.06355	0.05943
BW11 V38	0.59301	15.91869	0.05810	0.04109	–0.03999	–0.12999	0.04167	0.00375
BW11 V39	0.31226	15.90271	0.03575	0.03137	–0.01076	–0.13420	0.01516	0.00830
BW11 V44	0.48248	16.26245	–0.12438	0.04703	0.07152	0.16913	0.06336	0.00376
BW11 V55	0.28618	16.24522	–0.00384	–0.01892	0.02958	–0.12525	0.00902	0.00422

Table 6
Fourier coefficients for MM5A, MM5B, MM7A and MM7B RR Lyr stars.

Star	Period	a_0	a_1	a_2	a_3	b_1	b_2	b_3
MM5-A V6	0.51202	15.49398	–0.21193	–0.06483	–0.03117	0.05239	0.10877	0.01178
MM5-A V9	0.51619	15.70435	0.26126	–0.09831	0.03567	–0.00672	0.07100	–0.09076
MM5-A V15	0.60022	15.72056	0.09248	0.05317	–0.05042	–0.14779	0.07951	0.00156
MM5-A V18	0.52667	15.96786	–0.16892	0.01696	0.06189	0.14879	0.09686	0.03134
MM5-A V19	0.61251	15.92820	0.08290	0.09745	–0.06584	0.20467	–0.09701	–0.03419
MM5-A V20	0.39119	15.70409	–0.10723	–0.00904	0.01498	–0.07150	0.00763	–0.01238
MM5-A V21	0.46382	16.11532	–0.09888	0.05533	–0.00188	0.25375	–0.00806	–0.08262
MM5-A V27	0.62157	16.00873	0.09686	–0.02810	0.01729	–0.02969	0.02812	0.01586
MM5-A V32	0.54469	16.31287	0.11932	–0.00098	0.00096	–0.10804	0.04829	0.00440
MM5-A V37	0.45791	16.61944	0.08044	0.08155	–0.12812	0.26779	–0.12842	–0.00102
MM5-A V41	0.58450	16.55360	–0.22431	–0.16234	–0.10492	–0.10453	–0.00709	0.06610
MM5-A V46	0.37019	16.52867	0.19783	–0.06472	0.02040	0.02212	–0.02326	0.00951
MM5-B V4	0.52489	15.20260	0.16128	–0.06602	0.00139	0.10494	–0.06819	0.07335
MM5-B V10	0.52391	15.80769	0.21502	0.01624	–0.06884	–0.12193	0.13659	–0.05945
MM5-B V20	0.64994	15.87767	0.10679	–0.03176	–0.01329	–0.11265	0.05518	–0.03786
MM5-B V21	0.50359	16.10172	0.00034	0.13380	0.04152	0.23838	–0.04565	–0.08602
MM5-B V28	0.47995	16.26156	0.04026	0.04832	–0.09955	0.24168	–0.08479	0.00556
MM5-B V31	0.36456	16.47650	0.12577	0.00712	–0.06433	0.23951	–0.16559	0.06840
MM5-B V41	0.25745	16.29955	0.08252	0.01434	–0.02669	–0.11422	0.02376	–0.01327
MM5-B V44	0.52311	16.66455	0.20763	–0.08950	0.04017	0.13707	–0.08540	0.07512
MM7-A V2	0.54078	15.13520	0.17003	–0.06055	–0.00151	0.15396	–0.08457	0.06661
MM7-A V16	0.56710	15.87458	–0.09581	0.09339	0.08503	0.20386	0.04160	–0.02872
MM7-A V20	0.52984	16.02787	–0.24720	–0.14335	–0.07130	–0.13666	–0.06001	-0.08389
MM7-A V25	0.49380	15.96739	0.07652	0.00610	–0.05939	0.21915	–0.10446	0.01255
MM7-A V26	0.44361	16.16516	0.25202	–0.08683	0.05675	–0.00917	0.02388	–0.03266
MM7-A V34	0.53049	16.05563	–0.01475	0.03073	0.00438	–0.17186	–0.04794	0.02782
MM7-A V44	0.22759	16.12636	0.12231	–0.01129	–0.00137	–0.03649	0.01418	–0.03026
MM7-A V47	0.28782	16.20053	0.11638	0.01052	0.00575	–0.08639	0.03521	0.00012
MM7-A V94	0.27499	17.03946	0.01557	0.01524	0.01033	0.11992	0.00193	–0.01247
MM7-B V6	0.53913	15.66624	0.01717	0.06364	0.01106	–0.19809	–0.03479	0.05570
MM7-B V7	0.59002	15.73317	0.02054	0.08373	–0.06861	–0.20587	0.00904	0.05533
MM7-B V8	0.55940	15.69437	–0.04981	0.09440	0.01978	0.17077	0.02745	–0.05198
MM7-B V12	0.88121	15.69762	–0.06280	–0.00535	–0.00768	0.08718	0.03442	0.00477
MM7-B V13	0.53321	15.88185	–0.14795	–0.06607	–0.02875	–0.11044	–0.04872	-0.02883
MM7-B V14	0.28675	15.76076	0.07046	–0.00291	0.01445	–0.09978	0.01526	0.01005
MM7-B V63	0.61806	17.39339	0.24643	–0.11844	0.04429	–0.04129	0.08967	–0.04796

Table 7
Parameters of RR Lyr stars from Baade's Window.

Star	Period	$\langle I \rangle$	$\langle V-I \rangle$	I_0	$(V-I)_0$	V_{V-I}	Type
BWC V6	0.42765	15.172	1.215	14.289	0.629	13.351	RRab*
BWC V14	0.44022	15.719	0.904	14.841	0.311	14.363	RRab*
BWC V15	0.45871	15.918	0.807	14.928	0.151	14.708	RRab*
BWC V17	0.29872	15.339	0.939	–	–	13.929	RRc
BWC V22	0.48968	15.762	1.171	14.734	0.503	14.005	RRab*
BWC V23	0.45426	15.807	1.028	14.941	0.444	14.265	RRab*
BWC V25	0.47418	15.728	1.063	–	–	14.133	RRab
BWC V26	0.47863	16.012	1.273	15.120	0.669	14.102	RRab*
BWC V28	0.59478	15.625	1.262	14.623	0.604	13.732	RRab*
BWC V30	0.57147	15.667	1.164	14.659	0.482	13.921	RRab*
BWC V33	0.55032	15.832	1.224	14.942	0.618	13.996	RRab*
BWC V35	0.33048	15.611	1.063	14.600	0.398	14.017	RRc
BWC V37	0.38016	15.710	1.023	14.727	0.362	14.175	RRc
BWC V41	0.46214	15.998	1.325	14.923	0.626	14.010	RRab*
BWC V47	0.25692	15.829	0.800	–	–	14.629	RRc
BWC V48	0.33546	15.809	1.124	14.870	0.480	14.123	RRc
BWC V51	0.64949	15.806	1.286	14.875	0.666	13.876	RRab*
BWC V54	0.28870	15.916	0.958	–	–	14.479	RRc
BWC V56	0.68046	15.796	1.488	14.633	0.726	13.564	RRab*
BWC V59	0.26995	15.928	0.900	–	–	14.578	RRc
BWC V60	0.32069	15.907	1.047	14.972	0.425	14.336	RRc
BWC V61	0.61595	15.915	1.350	14.831	0.639	13.890	RRab*
BWC V62	0.28682	15.946	1.135	–	–	14.243	RRc
BWC V65	0.55720	16.249	0.507	15.231	–0.179	15.488	RRab*
BWC V81	0.38590	16.331	1.178	15.459	0.599	14.564	RRc
BWC V106	0.46496	16.987	1.508	15.943	0.826	14.726	RRab*
BW1 V7	0.46006	15.143	1.659	14.267	1.077	12.654	RRab*
BW1 V10	0.55564	15.397	1.045	14.468	0.429	13.830	RRab*
BW1 V11	0.38434	15.222	1.264	14.087	0.530	13.326	RRc
BW1 V14	0.49322	15.551	1.170	14.706	0.595	13.796	RRab*
BW1 V18	0.52956	15.730	1.111	14.756	0.456	14.062	RRab*
BW1 V19	0.44444	15.816	1.339	14.826	0.683	13.807	RRab*
BW1 V21	0.45411	15.820	1.233	14.814	0.555	13.970	RRab*
BW1 V25	0.60023	15.688	1.247	14.704	0.595	13.818	RRab*
BW1 V31	0.42434	16.026	1.189	–	–	14.242	RRab
BW1 V32	0.30529	15.726	0.967	14.833	0.387	14.275	RRc
BW1 V34	0.63271	15.894	1.223	14.957	0.598	14.059	RRab*
BW1 V36	0.44856	16.204	1.326	15.067	0.567	14.215	RRab*
BW1 V40	0.61175	15.847	1.256	14.859	0.636	13.964	RRab*
BW1 V43	0.42178	16.186	1.017	15.327	0.444	14.661	RRab*
BW1 V50	0.31992	16.252	0.909	–	–	14.889	RRc
BW1 V53	0.31963	16.104	1.138	15.072	0.442	14.397	RRc

Table 7
Continued

Star	Period	$\langle I\rangle$	$\langle V-I\rangle$	I_0	$(V-I)_0$	V_{V-I}	Type
BW2 V8	0.39402	15.300	1.171	14.257	0.472	13.544	RRc
BW2 V10	0.50784	15.370	1.050	14.295	0.360	13.796	RRc
BW2 V14	0.77102	15.578	–	–	–	–	RRab
BW2 V17	0.47838	15.977	–	–	–	–	RRab
BW2 V18	0.62432	15.770	1.139	14.764	0.501	14.061	RRc
BW2 V23	0.49276	16.241	0.990	15.188	0.294	14.757	RRab*
BW2 V24	0.59743	15.852	1.436	14.689	0.684	13.697	RRab*
BW2 V42	0.28954	16.462	1.038	15.424	0.366	14.904	RRc
BW3 V11	0.65494	15.352	1.372	14.030	0.491	13.294	RRab*
BW3 V13	0.45751	15.719	1.131	14.719	0.488	14.022	RRab*
BW3 V16	0.60354	15.745	1.289	14.477	0.445	13.811	RRab*
BW3 V17	0.40333	16.039	1.167	14.982	0.470	14.288	RRab*
BW3 V21	0.77304	15.681	1.292	14.599	0.589	13.743	RRab*
BW3 V26	0.33435	15.830	1.040	14.791	0.371	14.270	RRc
BW3 V41	0.26263	16.042	1.120	14.884	0.366	14.362	RRc
BW3 V43	0.64089	15.981	1.514	14.616	0.621	13.709	RRab*
BW3 V46	0.48653	16.226	1.335	14.995	0.499	14.223	RRab*
BW3 V48	0.25073	16.094	1.159	14.962	0.412	14.355	RRc
BW3 V61	0.54160	16.594	1.216	15.604	0.553	14.770	RRab*
BW3 V66	0.29103	16.428	1.171	15.248	0.386	14.671	RRc
BW3 V81	0.50818	16.731	–	–	–	–	RRab
BW3 V99	0.56046	17.110	1.488	15.435	0.384	14.877	RRab*
BW4 V4	0.31997	15.035	1.110	13.864	0.330	13.370	RRc
BW4 V5	0.47468	15.437	1.310	14.429	0.607	13.472	RRab*
BW4 V8	0.51586	15.464	1.155	14.536	0.527	13.731	RRab*
BW4 V9	0.46317	15.602	1.220	14.612	0.540	13.773	RRab*
BW4 V11	0.60169	15.338	1.159	14.400	0.517	13.600	RRab*
BW4 V12	0.63958	15.489	1.301	14.448	0.598	13.537	RRab*
BW4 V22	0.56093	15.799	1.408	14.780	0.687	13.687	RRab*
BW4 V25	0.32191	15.737	1.087	14.668	0.382	14.106	RRc
BW4 V27	0.34744	15.706	1.425	14.683	0.745	13.568	RRc
BW4 V31	0.32701	15.848	1.075	–	–	14.236	RRc
BW4 V43	0.55992	16.080	1.267	15.079	0.586	14.180	RRab*
BW4 V46	0.26256	16.067	1.022	15.146	0.387	14.533	RRc
BW4 V57	0.29085	16.490	0.769	15.526	0.111	15.337	RRc
BW4 V132	0.65076	17.412	1.248	16.504	0.623	15.540	RRab

Table 7
Completed

Star	Period	$\langle I \rangle$	$\langle V-I \rangle$	I_0	$(V-I)_0$	V_{V-I}	Type
BW5 V13	0.49492	15.745	0.997	14.856	0.390	14.250	RRab*
BW5 V17	0.27929	15.478	1.000	14.446	0.321	13.978	RRc
BW5 V24	0.55213	15.733	1.092	14.795	0.469	14.096	RRab*
BW5 V28	0.46723	16.032	1.086	15.061	0.453	14.403	RRab*
BW5 V29	0.47361	16.029	1.153	14.874	0.384	14.299	RRab*
BW5 V34	0.49027	16.206	1.267	15.078	0.506	14.306	RRab*
BW5 V36	0.59451	15.928	1.414	14.842	0.663	13.806	RRab*
BW5 V39	0.50786	16.313	1.471	15.177	0.709	14.106	RRab*
BW5 V40	0.32586	16.029	1.286	14.933	0.561	14.100	RRc
BW5 V43	0.45997	15.981	1.425	14.912	0.708	13.844	RRc
BW5 V50	0.49635	16.407	1.176	15.400	0.498	14.643	RRab*
BW5 V135	0.58825	17.700	1.707	–	–	15.140	RRab
BW5 V174	0.56146	18.956	1.066	17.900	0.365	17.356	RRab
BW6 V7	0.52501	15.442	1.164	14.404	0.468	13.696	RRab*
BW6 V12	0.55603	15.622	1.295	14.584	0.613	13.680	RRab*
BW6 V15	0.55745	15.527	1.661	14.490	1.011	13.036	RRab*
BW6 V17	0.65163	15.584	1.336	14.546	0.680	13.581	RRab*
BW6 V18	0.54140	15.933	1.401	14.777	0.639	13.831	RRab*
BW6 V20	0.39370	15.964	1.232	14.938	0.560	14.117	RRab*
BW6 V27	0.58400	15.760	1.517	14.610	0.754	13.485	RRab*
BW6 V29	0.56290	15.899	1.533	–	–	13.600	RRab
BW6 V32	0.31333	15.823	1.092	14.802	0.444	14.185	RRc
BW6 V35	0.43124	16.236	1.364	15.127	0.634	14.190	RRab*
BW6 V36	0.32026	15.953	1.109	14.917	0.419	14.290	RRc
BW6 V44	0.24855	16.195	0.871	15.170	0.217	14.890	RRc
BW6 V46	0.30942	16.073	1.144	15.004	0.440	14.357	RRc
BW7 V8	0.50711	15.293	1.056	14.301	0.402	13.709	RRab*
BW7 V15	0.49708	15.664	1.136	14.753	0.530	13.960	RRab*
BW7 V18	0.66695	15.672	1.215	14.389	0.393	13.850	RRab*
BW7 V20	0.77051	15.590	1.155	14.617	0.511	13.857	RRab*
BW7 V23	0.60579	15.478	1.273	14.506	0.632	13.567	RRab*
BW7 V24	0.26902	15.542	1.229	–	–	13.699	RRc
BW7 V25	0.52116	15.775	1.223	14.766	0.553	13.941	RRab*
BW7 V30	0.36202	15.768	1.125	14.790	0.486	14.080	RRc
BW7 V31	0.29191	15.972	0.920	14.894	0.222	14.592	RRc
BW7 V33	0.51122	16.160	1.761	14.746	0.797	13.518	RRab*
BW7 V48	0.63862	16.376	1.318	15.301	0.616	14.399	RRab*
BW7 V51	0.27215	16.591	1.029	15.177	0.060	15.049	RRc
BW8 V7	0.55454	15.199	1.107	14.280	0.493	13.539	RRab*
BW8 V8	0.78117	15.137	1.187	14.179	0.524	13.357	RRab*
BW8 V15	0.57724	15.432	1.109	14.593	0.558	13.768	RRab*
BW8 V16	0.42413	15.633	1.107	14.775	0.531	13.972	RRab*
BW8 V18	0.70001	15.367	1.248	14.385	0.570	13.495	RRab*
BW8 V20	0.67699	15.378	1.132	14.485	0.547	13.679	RRab*
BW8 V26	0.61699	15.483	1.176	14.593	0.588	13.720	RRab*
BW8 V28	0.53525	15.876	1.469	–	–	13.674	RRab
BW8 V34	0.32037	15.699	0.946	14.875	0.390	14.280	RRc
BW8 V35	0.64770	15.632	1.249	14.699	0.634	13.758	RRab*
BW8 V36	0.28612	15.779	0.971	14.913	0.408	14.322	RRc

Table 8
Parameters of RR Lyr stars from BW9, BW10 and BW11 fields.

Star	Period	$\langle I \rangle$	$\langle V - I \rangle$	V_{V-I}	Type
BW9 V14	0.60755	15.671	1.443	13.507	RRab*
BW9 V15	0.48592	16.007	1.182	14.234	RRab*
BW9 V22	0.63233	15.711	1.466	13.512	RRab*
BW9 V24	0.47635	15.901	1.450	13.727	RRab*
BW9 V34	0.44930	16.089	1.404	13.983	RRab*
BW9 V35	0.59252	15.954	1.548	13.632	RRab*
BW9 V37	0.54705	16.022	1.402	13.920	RRab*
BW9 V38	0.30574	15.891	1.292	13.952	RRc
BW9 V43	0.33260	15.985	1.586	13.606	RRc
BW9 V51	0.67741	16.586	1.023	15.051	RRab*
BW9 V52	0.34218	16.078	1.316	14.104	RRc
BW9 V54	0.54766	16.250	1.575	13.887	RRab*
BW9 V55	0.42564	16.411	1.412	14.293	RRab*
BW9 V59	0.54499	16.417	1.460	14.226	RRab*
BW9 V114	0.20767	16.906	1.460	14.716	RRc
BW9 V215	0.30284	17.821	1.401	15.719	RRc
BW10 V8	0.71337	15.107	–	–	RRab
BW10 V14	0.48410	15.436	1.784	12.760	RRab*
BW10 V20	0.52711	15.749	1.381	13.678	RRab*
BW10 V21	0.52204	15.497	1.388	13.415	RRab*
BW10 V27	0.25828	15.601	1.230	13.757	RRc
BW10 V36	0.27700	15.667	1.280	13.747	RRc
BW10 V39	0.51363	16.018	1.646	13.549	RRab*
BW10 V40	0.68277	15.757	1.385	13.679	RRab*
BW10 V41	0.62690	15.972			RRab*
BW10 V44	0.52727	15.977	1.501	13.725	RRab*
BW10 V45	0.25283	15.826	1.189	14.043	RRc
BW10 V46	0.32542	15.924	1.370	13.868	RRc
BW10 V48	0.32333	15.910	1.486	13.681	RRc
BW10 V51	0.27651	15.965	1.262	14.071	RRc
BW10 V56	0.61826	15.971	1.542	13.658	RRab*
BW10 V59	0.31930	16.112	1.237	14.257	RRc
BW10 V60	0.30371	16.158	1.544	13.842	RRc
BW10 V65	0.28099	16.190	1.073	14.580	RRc
BW10 V66	0.58123	16.351	1.484	14.125	RRab*
BW10 V70	0.28301	16.216	1.353	14.186	RRc
BW10 V95	0.63810	16.664	1.603	14.261	RRab*
BW11 V3	0.59598	14.590	1.284	12.664	RRab*
BW11 V10	0.45066	15.656	1.522	13.373	RRab*
BW11 V17	0.49491	15.852	1.357	13.817	RRab*
BW11 V23	0.27402	15.632	1.255	13.750	RRc
BW11 V25	0.51660	15.969	1.385	13.892	RRab*
BW11 V29	0.46610	16.055	1.580	13.685	RRab*
BW11 V34	0.34167	15.834	1.386	13.755	RRc
BW11 V36	0.51394	16.124	1.552	13.796	RRab*
BW11 V38	0.59301	15.915	1.488	13.683	RRab*
BW11 V39	0.31226	15.971	1.232	14.123	RRc
BW11 V44	0.48248	16.259	1.521	13.978	RRab*
BW11 V55	0.28618	16.243	1.459	14.053	RRc

Table 9
Parameters of RR Lyr stars from MM5 and MM7 fields.

Star	Period	$\langle I\rangle$	$\langle V-I\rangle$	V_{V-I}	Type
MM5-A V6	0.51202	15.491	1.781	12.819	RRab*
MM5-A V9	0.51619	15.696	1.368	13.643	RRab*
MM5-A V15	0.60022	15.720	1.282	13.798	RRab*
MM5-A V18	0.52667	15.969	1.597	13.573	RRab*
MM5-A V19	0.61251	15.929	1.466	13.730	RRab*
MM5-A V20	0.39119	15.706	1.171	13.949	RRc
MM5-A V21	0.46382	16.119	1.589	13.735	RRab*
MM5-A V27	0.62157	16.011	1.468	13.809	RRab*
MM5-A V32	0.54469	16.307	1.514	14.035	RRab*
MM5-A V37	0.45791	16.616	1.483	14.391	RRab*
MM5-A V41	0.58450	16.546	1.196	14.751	RRab*
MM5-A V46	0.37019	16.524	1.316	14.549	RRab*
MM5-B V4	0.52489	15.202	1.245	13.333	RRab*
MM5-B V10	0.52391	15.814	1.287	13.884	RRab*
MM5-B V20	0.64994	15.878	1.326	13.889	RRab*
MM5-B V21	0.50359	16.096	–	–	RRab
MM5-B V28	0.47995	16.266	0.932	14.868	RRab*
MM5-B V31	0.36456	16.589	1.041	15.027	RRab
MM5-B V41	0.25745	16.299	1.035	14.747	RRc
MM5-B V44	0.52311	16.667	1.205	14.860	RRab*
MM7-A V2	0.54078	15.141	1.153	13.411	RRab*
MM7-A V20	0.52984	16.036	1.561	13.694	RRab*
MM7-A V25	0.49380	15.965	–	–	RRab
MM7-A V26	0.44361	16.166	1.454	13.985	RRab*
MM7-A V34	0.53049	16.052	1.414	13.931	RRab*
MM7-A V44	0.22759	16.127	1.056	14.543	RRc
MM7-A V47	0.28782	16.200	1.291	14.264	RRc
MM7-A V94	0.27499	17.041	1.361	14.999	RRc
MM7-B V6	0.53913	15.670	1.367	13.619	RRab*
MM7-B V7	0.59002	15.733	1.312	13.765	RRab*
MM7-B V8	0.55940	15.694	1.362	13.650	RRab*
MM7-B V12	0.88121	15.698	1.500	13.447	RRab*
MM7-B V13	0.53321	15.948	1.378	13.881	RRab*
MM7-B V14	0.28675	15.764	1.212	13.947	RRc
MM7-B V63	0.61806	17.387	1.539	15.078	RRab

The map of interstellar extinction for BWC–BW8 OGLE fields given by Stanek (1996) was used to calculate free from interstellar extinction values of I_0 and $(V-I)_0$. Such data are presented in Tables 7–9. Each Table contains star designation, its period P in days, $\langle I \rangle$ (magnitude integrated) brightness, $V-I$ color (defined as $\langle V \rangle - \langle I \rangle$), I_0 brightness, $(V-I)_0$ color (last two values are available only for BWC–BW8 fields) and V_{V-I} parameter (see Section 3). The $V-I$ colors presented in this paper are slightly different than those given in the Catalog. This is a result of using in this work new V-band data collected in 1995 (not included in the first three parts of the Catalog) and of computing the mean value of $V-I$ instead of $V-I$ color at maximum brightness.

For a few stars $V-I$ color is not determined because of lack of the accurate V-band photometry. These stars are excluded from further analysis. We also omitted faint RR Lyr variables which are located behind the Galactic bulge (i.e. BW4 V132, BW5 V135, BW5 V174, MM7-B V63). Some of them most likely belong the to Sagittarius Dwarf Galaxy (see Alard 1996). Describing properties of RR Lyr variables we used mainly type ab of these stars. Clear discrimination between both types of RR Lyr stars, based only on amplitude defined as combination of Fourier coefficients (amp $= \sqrt{a_1^2 + b_1^2}$) and period of the star, is presented in Fig. 2. Recently Minniti *et al.* (1996) published preliminary results concerning RR Lyr variables in MACHO Collaboration database. They found three peaks in period distribution of RR Lyr stars in Large Magellanic Cloud (LMC) and Galactic bulge. The highest peak with longest value of period corresponded to RRab stars (variables pulsating in fundamental mode), the second peak near period 0.32–0.34^d corresponded to RRc stars (pulsating in 1st overtone) and the smallest peak with period around 0.27–0.28^d was interpreted as RRe stars (pulsations in 2nd overtone).

Similar distribution for OGLE RR Lyr stars from Galactic bulge is presented in Fig. 3. One can clearly distinguish two peaks: the higher corresponding to RRab stars and smaller corresponding to RRc variables. No clear peak connected with RRe stars is detected but assymetry in the shape of RRc peak might be caused by RRe stars.

All stars from Tables 7–9 used in further calculations are marked by asterisk. The objects from Tables 7–9 are presented in color magnitude diagram shown in Fig. 4. For comparison 20% of non-variable stars from BWC field are also plotted.

3 V_{V-I} Parameter for RR Lyr Stars in the Galactic Bulge

Stanek *et al.* (1994) used a well-defined population of bulge red clump stars to investigate the inner galactic structure. For this purpose they defined the extinction-insensitive V_{V-I} parameter:

$$V_{V-I} \equiv V - 2.6 \cdot (V-I) \tag{2}$$

with reddening law: $E_{V-I} = A_V/2.6$. The values of V_{V-I} showed clear correlation with galactic longitude l, where the smallest V_{V-I} were found in fields MM7 ($l \approx 5.5°$) and highest ones in fields MM5 ($l \approx -4.8°$). The difference in values of V_{V-I} between those fields amounted to 0.4 mag which implied the presence of a bar with the major axis inclined to the line of sight by 20–30 deg with axis ratios 3.5:1.5:1 (Stanek *et al.* 1997). In their discussion Stanek *et al.* (1994) pointed out that the changes of the brightness and color of red clump stars, which suggest presence of the bar, might be also caused by variations of A_V/E_{V-I} ratio. In the case when this ratio in BW fields is equal to 2.6, the values ~ 2.9 in MM5 fields and ~ 2.3 for MM7 fields would explain behavior of V_{V-I} parameter without assumption of presence of the Galactic bar.

Another group of stars which might be used to measure V_{V-I} in different fields of the Galactic center are RR Lyr stars. Using our sample and according to a new determination of A_V/E_{V-I} ratio made by Woźniak and Stanek (1996) and Stanek (1996) we took:

$$V_{V-I} \equiv V - 2.5 \cdot (V-I) \tag{3}$$

and computed the values of V_{V-I} presented in Tables 7–9.

Due to small number of RR Lyr stars in comparison to red clump giants we decided to calculate mean and median values of V_{V-I}. In calculations we used only ab type of RR Lyr stars marked in Tables 7–9 by asterisk. Results are presented in Fig. 5. No clear correlation between V_{V-I} and galactic longitude l in both cases is detected. It seems to suggest that there is no fluctuations in A_V/E_{V-I} ratio, the bar really exists and RR Lyr variables form a spherically symmetric inner halo around center of our Galaxy. The rims of that inner halo are most likely a beginning of the outer halo containing also RR Lyr variables and additionally globular clusters and blue horizontal branch stars. But accuracy of our determination of V_{V-I} for RR Lyr stars is low due to limited sample and one cannot totally exclude possibility of the presence of some dependence V_{V-I} on l for RR Lyr stars. Similar result for their W_{V-R} extinction insensitive parameter for RR Lyr stars was obtained by Minniti *et al.* (1996).

4 Conclusions

We presented parameters of the Fourier decomposition of light curves of RR Lyr type variable stars from The OGLE Catalog of Periodic Variable Stars in the Galactic Bulge. We also calculated values of mean $\langle I \rangle$ brightness, $V-I$ color and extinction insensitive V_{V-I} parameter for all RR Lyr stars in the Catalog. Additionally for fields with known interstellar extinction (Stanek 1996) i.e. BWC–BW8 we computed I_0 and $(V-I)_0$. Based on Fourier parameters we showed the way of clear discrimination between RRab and RRc stars. The construction of histogram with period distribution allowed us to find trace of third kind of RR Lyr stars (RRe pulsating in the 2nd overtone). Similar result was reported by Minniti *et al.* (1996) in population of RR Lyr stars in LMC and the Galactic bulge.

To check the stability of the A_V/E_{V-I} ratio in the fields in the Galactic bulge we also investigated the behavior of extinction insensitive parameter V_{V-I} for RR Lyr variables placed at different galactic longitudes. There is no clear trend between V_{V-I} and galactic longitude l but due to the small number of objects in our sample accuracy of determined mean values of V_{V-I} is low. If the lack of $V_{V-I}(l)$ dependence is real it means that RR Lyr variables form a spherically symmetric inner halo around center of our Galaxy. It also means that A_V/E_{V-I} ratio in all measured OGLE fields is stable and likely equal to 2.5 (Woźniak and Stanek 1996). This fact confirms the presence of the galactic bar which was found in the investigation of the red clump stars (Stanek *et al.* 1994, 1997).

To confirm above conclusions further observations of RR Lyr stars, especially in the fields with $|l| > 5°$, are needed.

All photometric parameters of RR Lyr stars presented in Tables 2–6 and 7–9 are available in electronic form via INTERNET from the following URL: *http://www.astrouw.edu.pl/∼olech/rrlyr.html*.

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FIGURE CAPTION

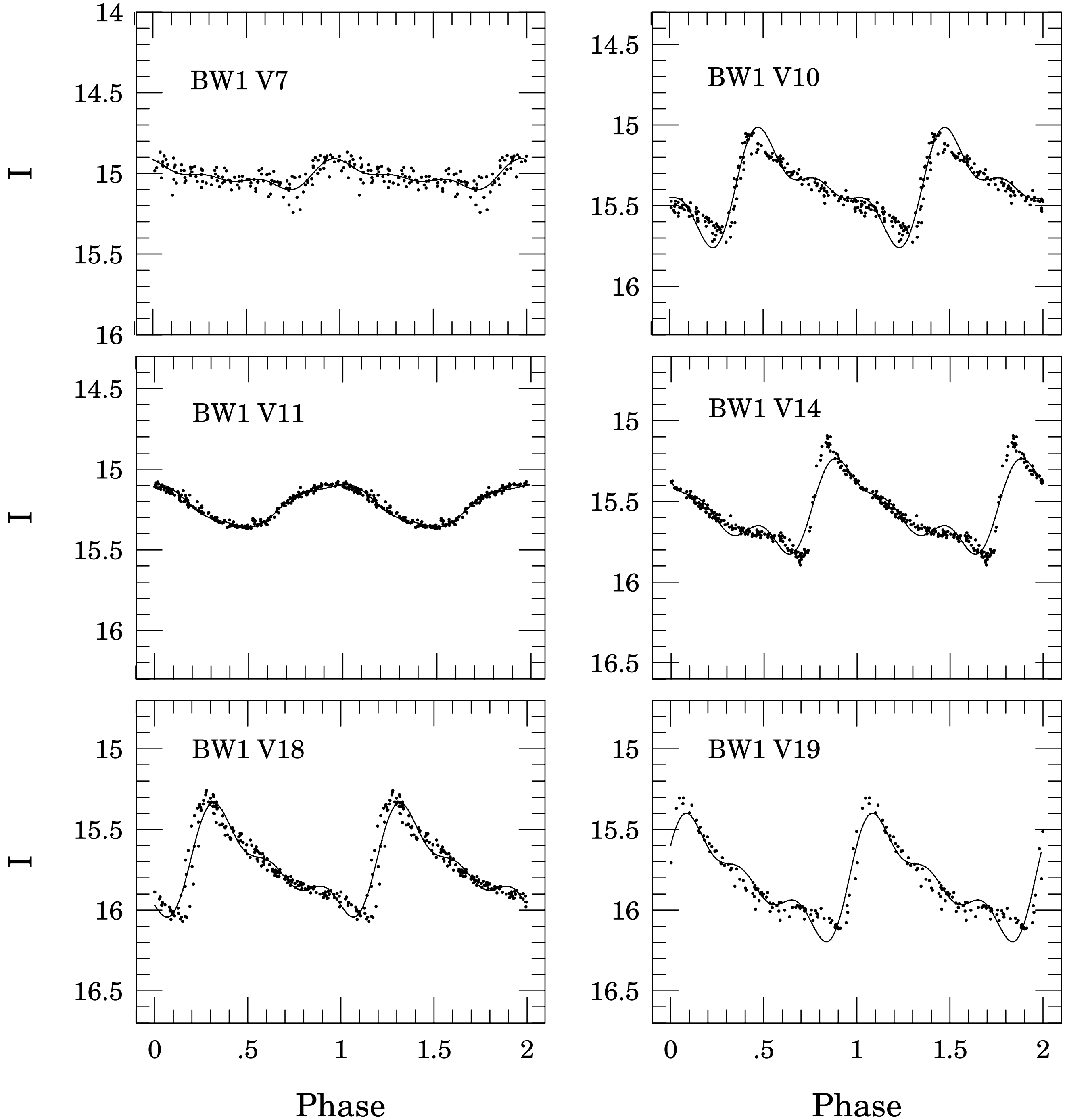
Fig. 1. Light curves of six RR Lyr stars from OGLE BW1 field. Solid line corresponds to the fit given by Eq. (1).

Fig. 2. Correlation between period and amplitude for RR Lyr stars from the Galactic bulge with clear discrimination between RRab and RRc variables. Open circles correspond to RRc variables and filled circles to RRab stars.

Fig. 3. The period distribution for RR Lyr stars in the Galactic bulge.

Fig. 4. Color–magnitude diagram for RR Lyr stars. Stars marked by open circles are located in BW fields. Crosses and open triangles correspond to RR Lyr variables from MM5 and MM7 fields, respectively.

Fig. 5. Correlation between extinction insensitive parameter V_{V-I} and galactic longitude l for RRab stars in OGLE database. See for comparison Minniti et al. (1996).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BW1 V10
BW1 V11
BW1 V14
BW1 V18
BW1 V19
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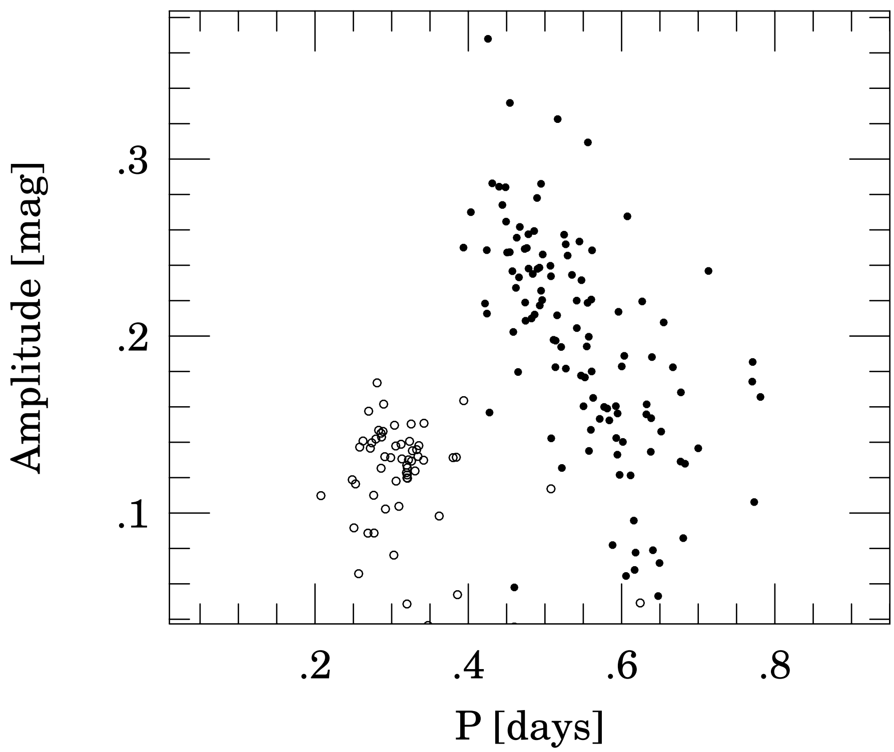
1
1.5
2



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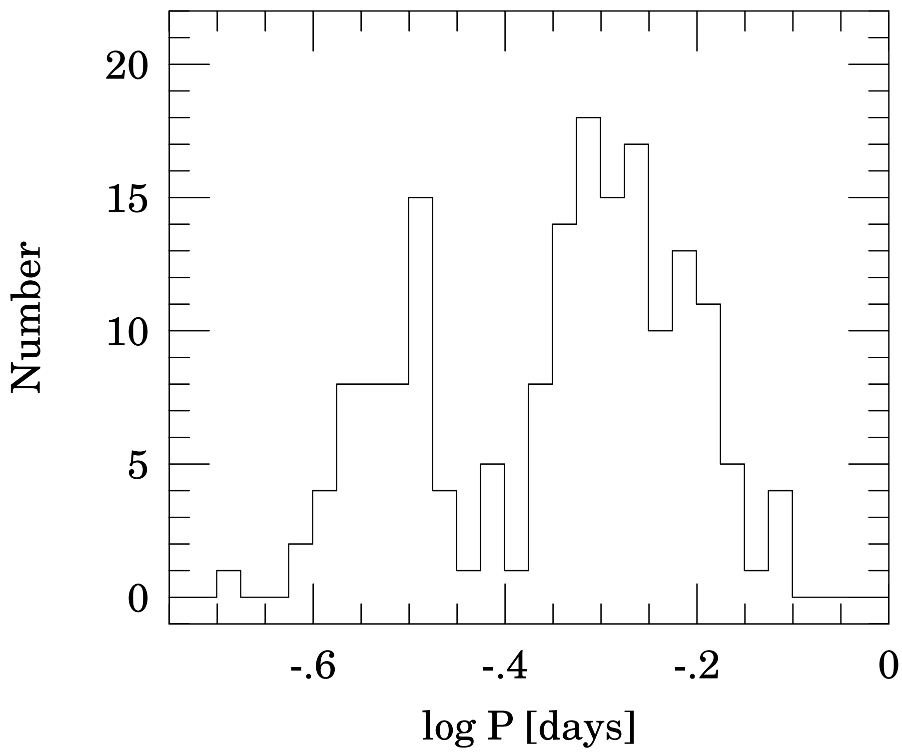
P [days]



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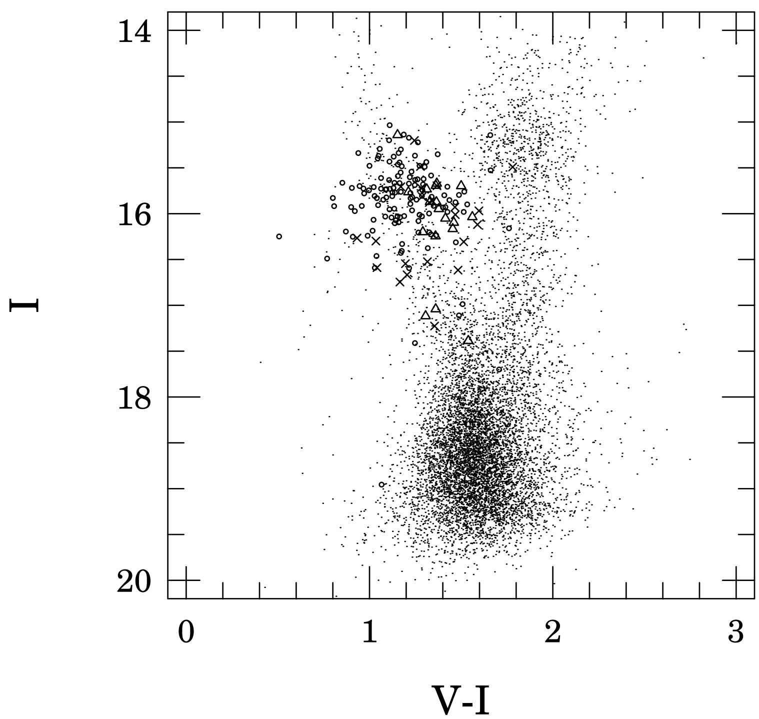

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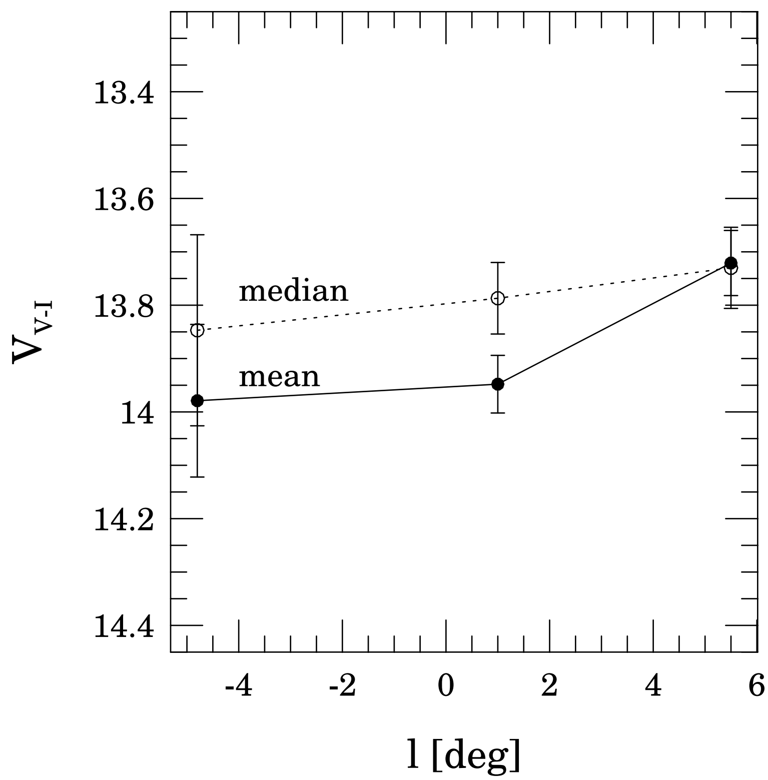
V-I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V_V-I
l [deg]